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AUTHOR Campbell, Donald L.; And Others
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ABSTRACT

The performance of two groups of 24 third-grade students practicing division problems was used to assess the effect of microcomputer drill programs on learning. An experimental group that used computer drill programs from the Milliken Math Sequences package was compared with a similar group that learned division using the traditional print drill method. Students in both groups received 30 minutes of daily classroom instruction in division prior to engaging in practice drill. Results indicate that, after a 5-week period of learning, there were no significant differences in the achievement levels of the two groups. These findings also suggest that use of computer drill materials may be no more effective than print drill materials for assisting third-grade students to achieve the 70% or above level performance established for this project. Three tables and a 10-item reference list are included. (Author/LMM)

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Effectiveness and Achievement: A Preliminary Comparison of Computer Assisted and Print Drill Performance Levels

Donald L. Campbell, Charles J. Horn,
Robert K. Leigh, and Dennis L. Peck
The University of Alabama
University, Alabama 35486

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ABSTRACT

The performance of two groups of third-grade students practicing division problems is used to assess the effect of microcomputer drill programs on learning. An experimental group of students, who used computer drill programs, is compared with a similar group of students, who learned how to do division problems using the traditional print drill method. The data indicate that after a five-week period of learning, no significant differences were observed in the achievement level of the two groups. These findings also suggest that use of computer drill materials may be no more effective than print drill materials for assisting third-grade students to achieve the 70 percent or above level performance established for this project.

INTRODUCTION

> The computer isn't good or bad. The computer is powerful . . . . In order to make this tool be good for us, we have to know more about how people interact with the machines. We have to study the intimacy and the power of this relationship and really understand how it works for different personalities--different kinds of children, for example, with different kinds of learning problems. (Quote attributed to Sherry Turkle by Joseph Barbata, The Chronicle of Higher Education, November 14, 1984).

Whether or not the American educational system is currently a part of what Turkle (1984) describes as a "culture in the making," the computer undeniably is affecting the lives of all (Petroski, 1984). Irrespective of this purported effect, the question with which the system of education in this country must contend is in fact a fundamental dilemna: Should computers be used as a part of the instructional process and in lieu of well established procedures involving classroom teachers? As Bork recently stated (1984:240), "many individuals are totally supportive of computers in education; others are totally opposed to them."

The use of computers in the schools is viewed by some observers as a key factor in compensating for past failures and eliminating or at least reducing future failures. Computers are also perceived by others as a mere fad (Bork, 1984). Despite the increasing presence of classroom computers and their use at all levels of education (Komoski, 1984) it remains that computers may not have had the intended effect portrayed by the news media (Wagschal, 1984). One reason why the impact of computers has been negligible, according to Wagschal (1984:251) ". . . is that U.S. education has shown remarkable resistance. . . to invasions by new technologies."

Other issues exist as well. Even though the microcomputer is being promoted as an educational tool of unprecedented power, the potential misuse of microcomputers should be considered (Campbell and Campbell, 1982; Pratt, 1984). As a teaching aid used to enhance the mathematical skills of primary school students, computer assisted instructional material may be effective and efficient. Evidence of this effect is not currently available, however.[1] It therefore seems reasonable to argue that computer learning methods be thoroughly evaluated, comparing these methods with the more traditional and accepted teaching procedures, prior to their unequivocal acceptance (Kellerman, 1984). We contend that before teachers completely abandon traditional methods of instruction, thereby embracing computer assisted instructional methods, evidence as to the effectiveness and efficiency of the microcomputer program in the learning process should be provided.

In this report we attempt to provide such information based on a study conducted by University of Alabama faculty members during early 1984. In this project a focus on the efficacy of computer mathematics drill and practice programs used in the third grade classroom setting is intended to assess the performance levels of two groups of students engaged in learning division of whole numbers.

METHOD

The Setting and Sample

The study was conducted during early 1984 in a middle-class suburban school district located in a large Southeastern city. A matched pairs design was employed to assign the all white third grade students either to the experimental computer drill and practice group (N = 24) or the print drill and

practice control group (N = 24). Pairs were matched on the basis of teacher recommendations and the achievement scores recorded in a pre-test of the division problem material to be covered (see Table 1). To ensure consistency with classroom objectives, 50 of the 64 problem levels available in the Milliken drill program were used during the five-week study.

The Microcomputer Drill Program

The Milliken Math Sequences package (1980) is designed to provide mathematical drill and practice exercises for students in grades one through eight. The division drill and practice diskette is recommended as appropriate for third grade students. The publisher further recommends that the package be used after students receive classroom instruction. By this we assume that the publisher is aware that a high degree of memorization is required before students are able to master the logic and procedures involved in mathematics.

Table 1 about here

As shown in Table 1, the exercises consist of various levels of difficulty. At each level division problems are randomly generated and a question mark appears on the screen to indicate that the student is required to enter a correct response. Two types of learning reinforcement are provided when correct answers are entered by the student. The first, animation, consists of cartoon-like characters; the second, written reinforcement, consists of simple phrases such as "Well done" and "Good job."

Generally students are given two chances to work a problem correctly. For exercise problems requiring a greater number of operations, such as long

division, the computer is programed to provide one additional chance for every seven correct responses. When a problem is incorrectly answered, the proper response appears on the screen and the user is instructed to "study it."

In order to advance to the next degree of difficulty, students were required to achieve the specified performance level which, for this project, was set at 70 percent correct for passing with the mastery level set at 90 percent. When a student successfully completed the specified number of problems and achieved a level of passing, he or she automatically advanced to the next problem level. However, the computer program dropped down one problem level if three consecutive problems were missed or if the student's overall score fell below passing after completion of a specified number of problems. When failure occurred, students were required to meet with the teacher. This procedure also was useful for monitoring student performance, since the computer is programed to prevent students from entering an advanced sequence until a new assignment is given. Provided that the student's overall score was 70 or above, the computer continued to generate new problems at the same level of difficulty until the minimum number of problems were completed (N = 20).

The Print Drill Program

Three printed drill sheets consisting of 50 problems randomly generated from the computer drill program were used at each level. Students in the control group were provided with a division problem set and allowed to work the entire exercise without assistance from a teacher. Equivalent 50-item paper and pencil tests were used for the pre-test, weekly progress tests, and the post-test. Each test included combinations available in the computer program format inclusive of level 50.

Students in both groups received 30 minutes of daily classroom instruction in division prior to engaging in practice drills. Members of the experimental group were then assigned to use the computer for approximately 20 minutes of drill and practice while the print group used paper and pencil worksheets during a similar 20-minute practice session. As the performance of the computer group met the prescribed criteria for each level of difficulty, the computer program automatically advanced to the next level of instruction. Individual performances of the control group were monitored and evaluated by classroom teachers who used criteria similar to those employed to evaluate the experimental group. When the performance level of control group subjects did not meet the criteria established for the study, alternate print drill sheets were provided and additional practice was required. Upon successful completion of an exercise, control group students received worksheets for the next problem level.

Alternate versions of the test were administered weekly to determine student progress. Test results were collected by members of the research team, but the teachers were not informed of the students' performance. Upon completion of the experiment, a post-test was administered to both groups.

Two null hypotheses were tested. The first null hypothesis, intended to test effectiveness, is:

> There will be no difference in the performance of third-grade mathematics students who use a computer drill and practice program and those using traditional print materials.

The second hypothesis, to test achievement, is as follows:

> No difference will be found in the performance levels of the two groups at the end of the five-week test period.

Acceptable achievement for each level was set at 70-89; a 90 percent

performance level was defined as mastery of the material. It was also required that a minimum of 20 problems be completed for each level.

RESULTS

Student Achievement and Computer Effectiveness

Achievement was observed at the end of each week by comparing test scores, and technique effectiveness was evaluated by noting the performance scores and the length of time required by students to reach the 90 percent performance level. In Table 2 individual scores for both groups are reported, and the weekly performance is statistically evaluated using a two-tailed t-test. Although the t-test revealed that no significant statistical difference existed between the two groups on the pre-test, one week later the difference in performance was significant ($P<.01$). After week one, however, statistical significant differences disappeared. While the post-test difference between the groups is negligible, the frequency data clearly demonstrate that the print drill group was more effective than the computer group.

Insert Table 2 about here

Achievement

A summary of the distribution data is shown in Table 3. Examination of these data reveals several differences between the two groups. Only five members of the print group and four members of the computer group had achieved the 90 percent performance level on the pre-test. By the end of week one, 17 students assigned to the control group achieved this level in contrast to

only six students assigned to the experimental computer group. Throughout the remaining weeks of the experiment, the control group continued to perform at a superior level and by the end of week four, 20 members of this print drill group had reached the 90 percentile level.

Table 3 about here

In contrast, the performance of the computer group was low. While 71 percent of the control group mastered the division problem material within two weeks, more than one-half of the experimental group failed to reach the 90 percent level within a similar period of time. Moreover, only 14 members (58 percent) of the computer drill group were able to master the material by the end of week three, but 18 (75 percent) were able to do so by the end of the experiment.

The period required to reach a prescribed level should be considered when the efficacy of instructional materials is evaluated. The finding that computer based materials may be less effective than are traditional print drill materials has some important implications. The replacement of a teaching technique which has been shown to be effective with an inadequately tested method also has imposing implications.

DISCUSSION

During a five-week period the classroom performance of two groups of third grade students learning to solve division problems was evaluated. A slightly greater proportion of those who used the print drill and practice

materials achieved a performance commensurate with the mastery level and were able to do so within a shorter time than did those using computer drill materials. Thus, the null hypotheses were not confirmed. These findings have important consequences. When the cost of computer equipment and software is considered, for example, selective use of computer assisted teaching techniques should also be considered.

Both techniques employed in this experiment appear to be effective, but progress toward mastery of the mathematical materials appears to be greater among the control print drill group. Differences observed in the overall performance levels of the two groups suggest that the use of print materials may be more efficient. This evidence further suggests that the use of computers does not produce results equal to traditional teaching methods, and that the use of computers may actually inhibit student performance.

One reason which can be suggested for the slow progress of the experimental group is that once students were familiar with the computer, they may have become impatient when required to wait for new problems while reinforcement messages appeared on the screen. Control group members, on the other hand, were able to move along from problem to problem without interruption.

These findings are preliminary and refer to students at a single elementary school. Further research is needed in response to a number of issues. At the very least, research should be conducted to determine whether:

1. computer reinforcement is more effective than traditional teaching methods; and whether

2. student learning is enhanced and performance measurably improved by the use of computer techniques.

Campbell and Campbell (1982:89) stated that "Microcomputers . . . should be used when--and only when--they are the most effective way to meet educational objectives." In this regard it is incumbent upon software vendors to provide data that demonstrate the effectiveness of computer assisted methods on student performance.

One question that begs answering is: Does the use of computers provide a greater learning potential for students than time spent reading and discussing through traditional teaching methods. Some preliminary evidence to this effect was reported by Asbell (1984), and a full evaluation of the effectiveness of computers among first grade students is currently being conducted by the Educational Testing Service of Princeton, New Jersey. Supported by a $2 million grant from the IBM Corporation, a two-year demonstration project, Writing to Read, holds a great potential for revolutionizing our educational system. Until the data are fully analyzed, however, a conservative approach to evaluating the use of computers among grade school students seems reasonable.

Print materials have been demonstrated to be effective, and this may be reason enough to be wary of the suggestion that this method be abandoned entirely. Until computers are proven to be effective, teachers and administrators alike should not be intimidated by current statements predicated on the belief that individuals who do not use computers are functionally illiterate.

END NOTES

1. In a survey of microcomputer software providers conducted by three of the co-authors during late 1984, 582 manufacturers were requested to provide empirical evidence in support of claims made in their promotional literature that use of microcomputers in the classroom setting enhanced student performance levels. Although a large number of companies replied (N=295), none were able to supply information which scientifically supported advertised performance claims.

Table 1. Example Problems Contained in Computer Mathematics Package

Problem Level	Description	Examples
1	Missing factors 0 - 9; Divisors 1-2, Dividends 0 - 20; Multiples of 2.	? / 2 = 10
10-11	Missing quotients 1 - 9; Divisors 1 or 10; Dividends 1 - 9 and 10 - 90; Multiples of 10.	8 / 1 = X X 10) 70
20-21	Missing quotients 1 - 9; Divisor is 4; Dividends 4 - 36; Multiples of 4.	24 / 4 = X X 4) 16
30	Missing factors 0 - 8; Divisor is 8; Dividends 0 - 72; Multiples of 8	? / 8 = 0
40	Quotients 1 - 9; Divisors 2 - 9; Dividends 10 - 19; Remainders possible.	X 2) 17
50	Quotients 1000 - 4999; Divisors 2 - 9 Dividends 1000 - 9999; Remainders possible.	XXXX 7) 8234

Table 2. Performance of Control (Print) and Experimental (Computer) Groups on 50-item Tests.

Student	Print Pre-test	Computer Pre-test	Control (Print) Week 1	Week 2	Week 3	Week 4	Experimental (Computer) Week 1	Week 2	Week 3	Week 4	Print Post-test	Computer Post-test
1	49	49	49	50	49	49	49	48	50	49	50	49
2	48	48	50	49	49	50	48	49	49	50	50	50
3	47	47	47	50	48	49	49	48	48	49	49	49
4	47	47	44	46	47	48	49	47	48	49	49	49
5	47	42	49	48	49	50	42	42	43	49	47	47
6	44	42	46	43	45	47	42	49	49	50	46	47
7	44	30	48	47	48	49	45	47	47	49	48	48
8	43	28	47	46	47	48	28	37	44	47	48	47
9	41	27	49	50	49	49	26	31	34	39	50	36
10	38	27	45	46	49	48	27	37	47	47	48	47
11	38	26	48	49	49	49	36	36	41	47	50	48
12	32	23	47	48	49	50	44	44	46	48	50	49
13	31	21	48	45	47	49	21	36	39	36	47	39
14	27	21	47	48	50	50	21	40	46	50	50	46
15	25	19	46	32	40	48	19	37	29	38	44	43
16	24	15	46	45	48	49	16	46	50	50	47	47
17	14	9	46	46	39	49	49	49	50	50	49	48
18	6	8	13	41	35	24	29	48	48	50	27	47
19	5	7	46	36	42	49	39	41	29	45	48	45
20	4	7	39	26	37	48	38	43	40	42	43	40
21	3	7	40	31	40	36	38	49	47	48	48	46
22	2	5	35	49	45	49	15	28	35	36	48	31
23	2	3	44	20	20	44	39	47	46	50	44	49
24	1	2	39	44	49	49	15	33	35	33	46	37
Mean	27.58	23.33	44.08	43.13	44.58	46.96	34.33	42.17	43.33	45.88	46.92	44.96
S. D.	18.14	15.78	7.59	8.15	6.83	5.68	12.00	6.42	6.59	5.38	4.70	5.39

T-tests: Pre-test = .87; Progress 1 = 3.36; Progress 2 = .45; Progress 3 = .66; Progress 4 = .68; Post-test = 1.34

Table 3. Time Required to Reach Criterion Score of 90 percent on 50-Item Division Test

Time to Reach Criterion	Control Print Group (N = 24)		Experimental Computer Group (N = 24)	
	N Respondents	Percentage	N Respondents	Percentage
Pre-test	5	20.8	4	16.7
Week 1	17	70.8	6	25.0
Week 2	16	66.7	11	45.8
Week 3	17	70.8	14	58.3
Week 4	21	87.5	18	75.0
Post-test	20	83.3	18	75.0

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